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# Effective Computer Based Resources for Teaching Inquiry Based Science: The GLOBE Program

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# EFFECTIVE COMPUTER-BASED RESOURCES FOR TEACHING INQUIRY-BASED SCIENCE: THE GLOBE PROGRAM



University of the Philippines  
National Institute for Science and  
Mathematics Education Development  
NISMED International Conference  
October 28-30, 2014

Sherry S. Herron, Ph.D.  
University of Southern Mississippi

# DEDICATION

My major professor and mentor, Dr. Rosalina 'Lina' Villavicencio Hairston, who first introduced me to NSTA, NARST, BSCS and GLOBE.

My Filipino family: Pia Campo, Josephine Estrera, Peter Orbita, and Miliza Romero.

# COMPUTERS ARE HERE

More than half of the teachers surveyed across the U.S. reported that using digital technologies has strongly influenced the ways they teach.

~ 80% see computer use as important to the success of their professional work - for administration, communication, planning, and instruction.

Yet only 37% of the same sample reported using computers with their students daily. (p. 18).

Harris, J. (2008). One size doesn't fit all: Customizing educational technology professional development. *Learning & Leading with Technology*, February 2008, 18-23.

# INQUIRY IS HERE

John Thornton, a retired biology professor who was a pioneer in the field of investigative laboratories, said:

*“The general notion that you should engage students in investigations as a vehicle to teaching them science wasn’t anything new 25 years ago. What was new then, and is still new now, is the idea that you can use this approach with all students”.*

Howard Hughes Medical Institute Report, 1997, p. 32

Math and Science Standards promote inquiry and the use of authentic data.

# COMPUTER TECHNOLOGIES FACILITATE INQUIRY

PhET: University of Colorado, Boulder: [phet.colorado.edu/](http://phet.colorado.edu/)

- Free online educational simulations covering a diverse topics designed by the University of Colorado Boulder available in many languages.

HHMI: Howard Hughes Medical Institute

Dolan DNA Learning Center: Cold Spring Harbor

<http://www.dnalc.org/resources>;

<http://www.dnalc.org/websites>

Learn.Genetics: University of Utah

<http://learn.genetics.utah.edu>

Free Apple Apps, including Augmented Reality

Texas Instruments Graphing Calculators combined with sensors and probes

# NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA)

Example: Digital coast *“More Than Just Data”*

How can data be collected if you can't get to far away spots? “Adopt a Drifter”!

Drop an instrument overboard and let the current take it where it will. Ground true-thing in the ocean! A class can adopt an instrument, follow its path, and record the data it is collecting.

<http://www.noaa.gov/climate>

[www.estuaries.noaa.gov](http://www.estuaries.noaa.gov)

<http://dataintheclassroom.org>

[www.climate.gov](http://www.climate.gov)



**THE GLOBE PROGRAM**  
CONNECTING THE NEXT GENERATION OF SCIENTISTS

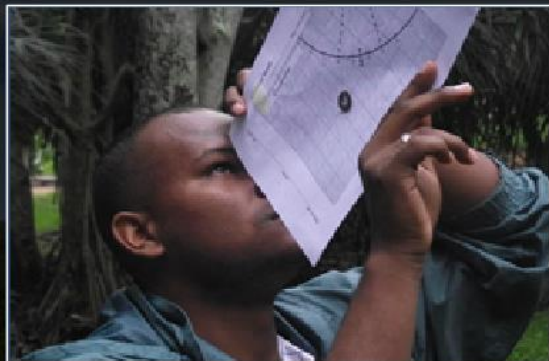


## *Global Learning and Observations to Benefit the Environment*

<http://www.globe.gov/>

- Began on Earth Day 1995
  - 112 participating countries
  - 58,000 GLOBE-trained teachers
  - > 25,000 schools
  - > 1.5 million students
  - > 23 million measurements





## Fourteen Countries Meet in Africa to Discuss GLOBE Student Research Achievements

Antananarivo, Madagascar served as the location of the 7th GLOBE Africa Regional Meeting in February 2012. Leaders from the 22 GLOBE countries in Africa met to discuss important issues related to implementation of GLOBE in their countries and to work towards greater participation,

31/74 ◀ prev | next ▶



## Welcome to GLOBE

The Global Learning and Observations to Benefit the Environment (GLOBE) program is a worldwide hands-on, primary and secondary school-based science and education program.

[Learn More about GLOBE](#) ▶



## GLOBE Community



[See Members](#) ▶

**Schools:**  
27,898

**Teachers:**  
20,798

**Total Measurements:**  
125,290,543

[Enter Live Data](#) ▶

[Enter Training Data](#) ▶

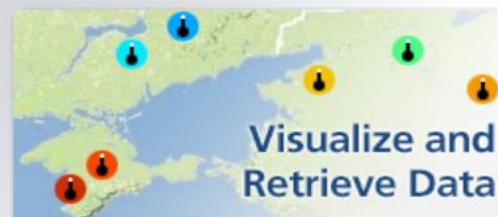
### Collaboration Groups

Recent Postings In:  
[Community Feedback Forum](#)

**Thumbnail View of Documents**  
When I am choosing a PPT, Word doc or PDF file to download, it would be nice to



**The Student ZONE**  
Learn how to be a student GLOBE scientist



**Visualize and Retrieve Data**

## GLOBE Teacher's Guide

[Overview](#)[Implementation Guide](#)[Authors & Editors](#)

### Overview

In the GLOBE Teacher's Guide, protocols and learning activities are related to the standards they address. In the United States, there is growing insistence that teaching be directed to address specific standards. Many countries in GLOBE and virtually every state in the United States have adopted standards for education, including science education. These standards vary, and it is not presently possible to provide a correspondence between GLOBE elements and every set of standards. However, there is much in common among the different sets of standards for science education.

For this Teacher's Guide, GLOBE has chosen to use the National Science Education Standards published by the US National Academy of Sciences, selected additional content standards that GLOBE scientists and educators feel might make appropriate additions to standards, and the National Geography Standards prepared by the (US) National Education Standards Project.

### Teacher's Guide

#### Introduction

[English](#)[Spanish](#)[French](#)[German](#)

**GLOBE provides five scientific investigation areas, each providing background information, measurement protocols and learning activities. Resources from the five areas can be combined in many ways, providing students and educators with many options for building meaningful scientific investigations. Also provided are data sheets and field guides to assist in the accurate collection of data.**

[Atmosphere](#)[Earth as a System](#)[Hydrology](#)[Land Cover/Biology](#)[Soil](#)

# YOU TUBE CHANNEL

GLOBE Learning Expedition held in August 2014, Delhi, India

[https://www.youtube.com/watch?v=osSolISKq4o&list=PLfpnkASII\\_NYBUCwa0uZP53YutlHllcgf](https://www.youtube.com/watch?v=osSolISKq4o&list=PLfpnkASII_NYBUCwa0uZP53YutlHllcgf)

GLOBE Salute to Teachers

<https://www.youtube.com/channel/UCWSToq833hSt2meu8PWhrjQ>



# GLOBE Satellite Partnerships



**Connecting Students to  
GLOBE Partner Satellite Missions**

## Field Campaigns

[Field Campaigns](#) [Satellite Partnerships](#) [Earth System Science Projects](#) [Field Campaign Archive](#)

[NASA Satellite Overpass Calculator](#)

[Cloud Sat](#)

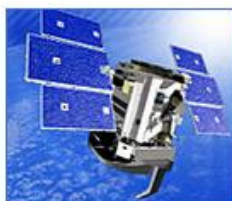
[CALIPSO](#)

[GPM](#)

[SMAP](#)

### Satellite Partnerships

Along with our current CloudSat and CALIPSO Missions, 2014 will be an exciting year for NASA Missions and GLOBE! Here are four opportunities to take part in GLOBE Campaigns related to NASA Missions: CloudSat, CALIPSO, Global Precipitation Measurement (GPM) and Soil Moisture Active Passive Mission (SMAP).



#### CloudSat

Clouds influence Earth's weather and climate. They bring water from the air to the ground and from one region of the globe to another. Clouds also have a large impact on Earth's radiation budget; even small changes in cloud abundance or distribution could affect climate.

GLOBE students and teachers can collect and enter data that will be compared to CloudSat measurements. CloudSat, in turn, contributes Earth science learning opportunities to lifelong learners and shares the results of CloudSat's scientific research mission to improve our understanding of clouds and global climate change.



#### CALIPSO

CALIPSO, a joint mission between NASA and the French Space Agency, CNES, provides new insight into the role that clouds and atmospheric aerosols (airborne particulates) play in regulating Earth's weather, climate, and air quality.

CALIPSO combines an active lidar instrument with passive infrared and visible imagers to probe the vertical structure and properties of thin clouds and aerosols over the globe.



#### Global Precipitation Measurement (GPM)

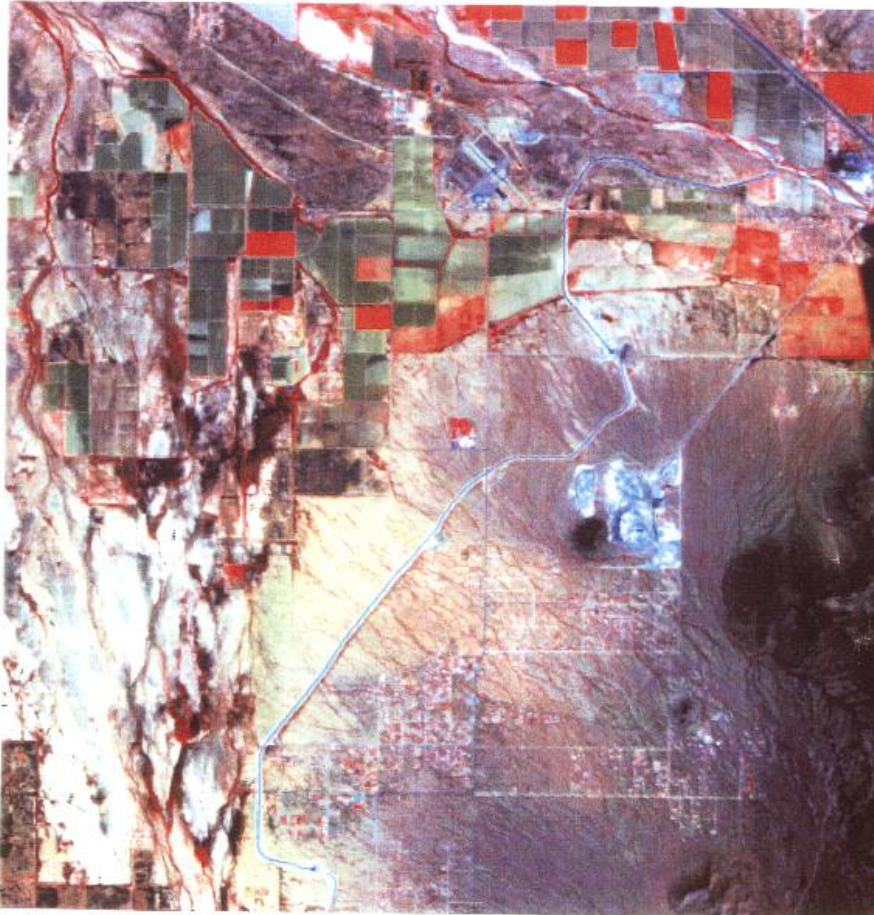
The Global Precipitation Measurement (GPM) satellite mission "will use multiple satellites orbiting Earth to collect rain, snow and other precipitation data worldwide every three hours." In GLOBE, students also take regular precipitation data. Updates [here](#).



**GLOBE students at Marana High School in Tuscon, AZ worked with Landsat images and data within the Land Cover investigation, conducting ground-truth measurements of land cover types.**

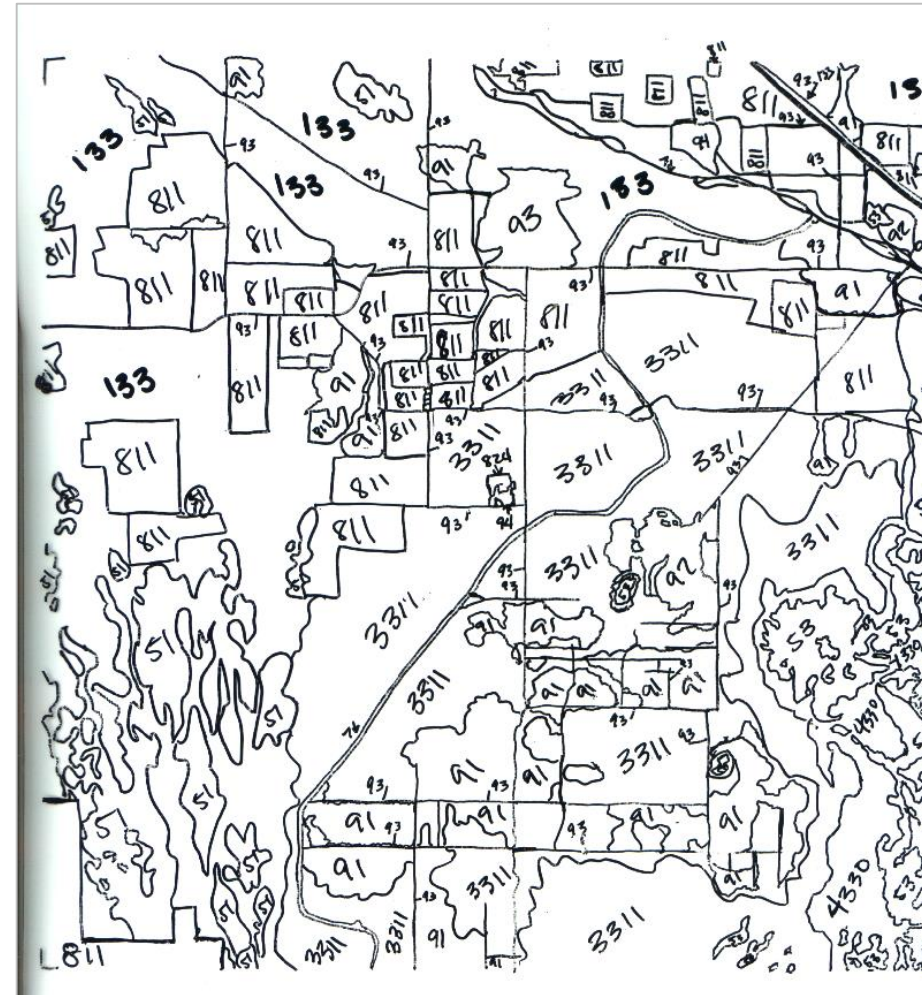
Marana High School

Bands: 4,3,2 Acquisition: 05/14/91



282 hubb 18/05/98 09:56 no

**Infrared** Landsat image of Marana High School



The land cover map created by GLOBE students



# GLOBE students in the U.S. and Germany did ground-truthing of the MODIS sensor flying on the Terra satellite.



This research was also a winning 2003 GLE student report

## ASSESSING SATELLITE-BASED AEROSOL RETRIEVALS AND GROUND TRUTH VALIDATION FOR TERRA'S MODIS SENSOR OVER URBAN AREAS USING THE GLOBE PROGRAM'S HANDHELD SUN PHOTOMETERS

Melanie Benetato, Gianna D'Emilio, Jordan Glist, Chris Hanawalt: Students  
Edmund Burke School, Washington, DC, USA

Frank Niepold, High School Science Teacher  
Edmund Burke School, Washington, DC, USA

### Abstract

The Edmund Burke School collected numerous GLOBE measurements from 2002 to the present. Working with David Brooks in his scientist, teacher, student partnership concept, Gianna D'Emilio, a Burke ninth grade student, expanded her 9<sup>th</sup> grade science fair project into a much larger undertaking. Gianna and three other students took aerosol measurements coinciding with the times of overflights of the Earth-observing spacecraft TERRA because "ground truth validation" is an essential component of any program that attempts to use space-based measurements to study Earth's atmosphere. The MODIS measurements collected on TERRA were used to calculate aerosol optical thickness (AOT) at several wavelengths. The team of students completed nine months of AOT measurements, refined the GLOBE *Aerosol Protocol* and has established a data analysis protocol to be used by another team of trained students as part of their long-term science education. The results presented in this paper are inconclusive due to a number of unknown variables. Although GLOBE's ground validation yielded values 0.64 - 4.08 standard deviations below the MODIS AOT values, we cannot be sure whether this is due to procedural (systematic), or random discrepancies.

### Research Question

Can the accuracy of MODIS' Aerosol Optical Thickness observations be validated over urban areas by GLOBE's ground validation techniques?

### Background

Aerosols have both natural and man-made sources. Volcanoes, dust storms, agricultural activity, marine spray, air pollution from industrial activity, fossil fuel burning, and forest fires all contribute, influencing both weather and climate. The details of their effect on climate (and, in particular, on models for



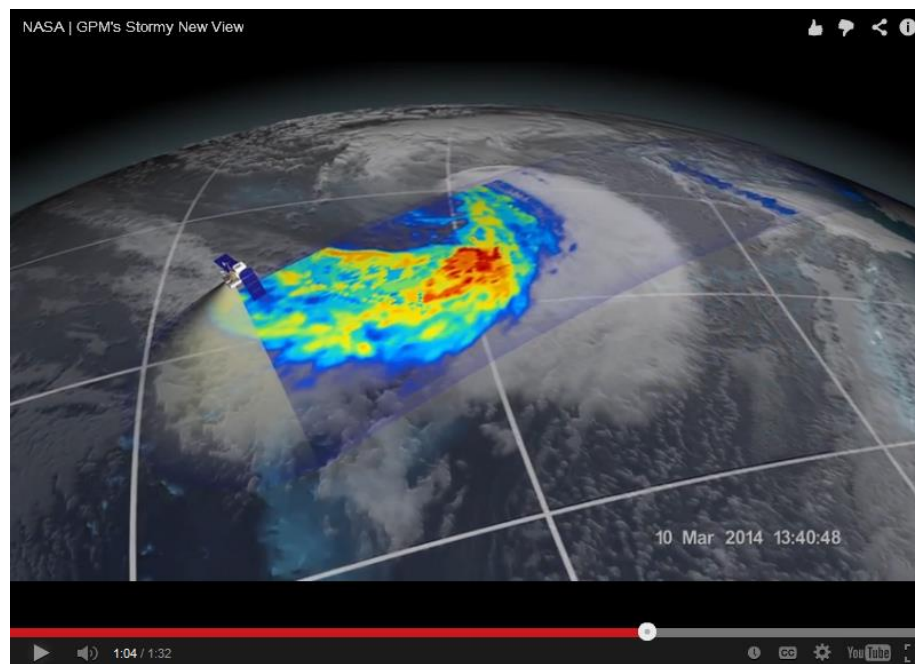
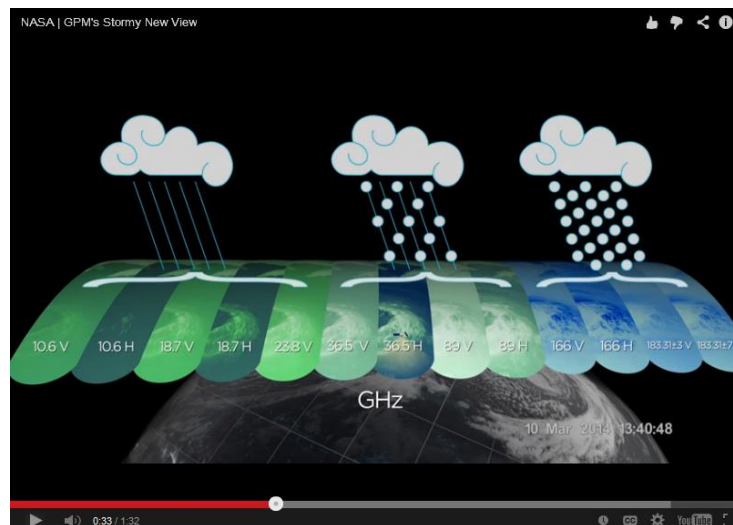
**CloudSat and CALIPSO missions became satellite partnerships with GLOBE.**



**Students gather around a CloudSat convex mirror.**

**Teachers learn how to use sun photometers to collect aerosol data and observe clouds in four quadrants of the sky.**



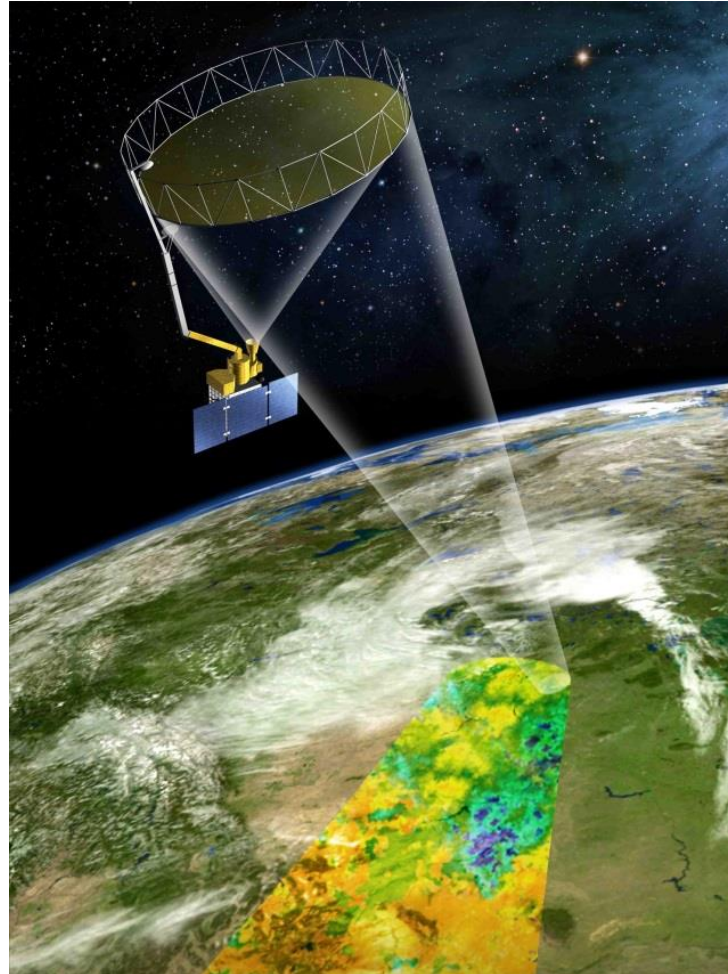


**These first images show precipitation falling inside a cyclone over the northwest Pacific Ocean, 1700 km east of Japan.**

# SMAP: Soil Moisture Active Passive

Scheduled to launch in November 2014

**2 sensors** – both in the Microwave range, will allow the satellite instruments to collect data regardless of cloud cover and light.



## **Active/Passive Mission:**

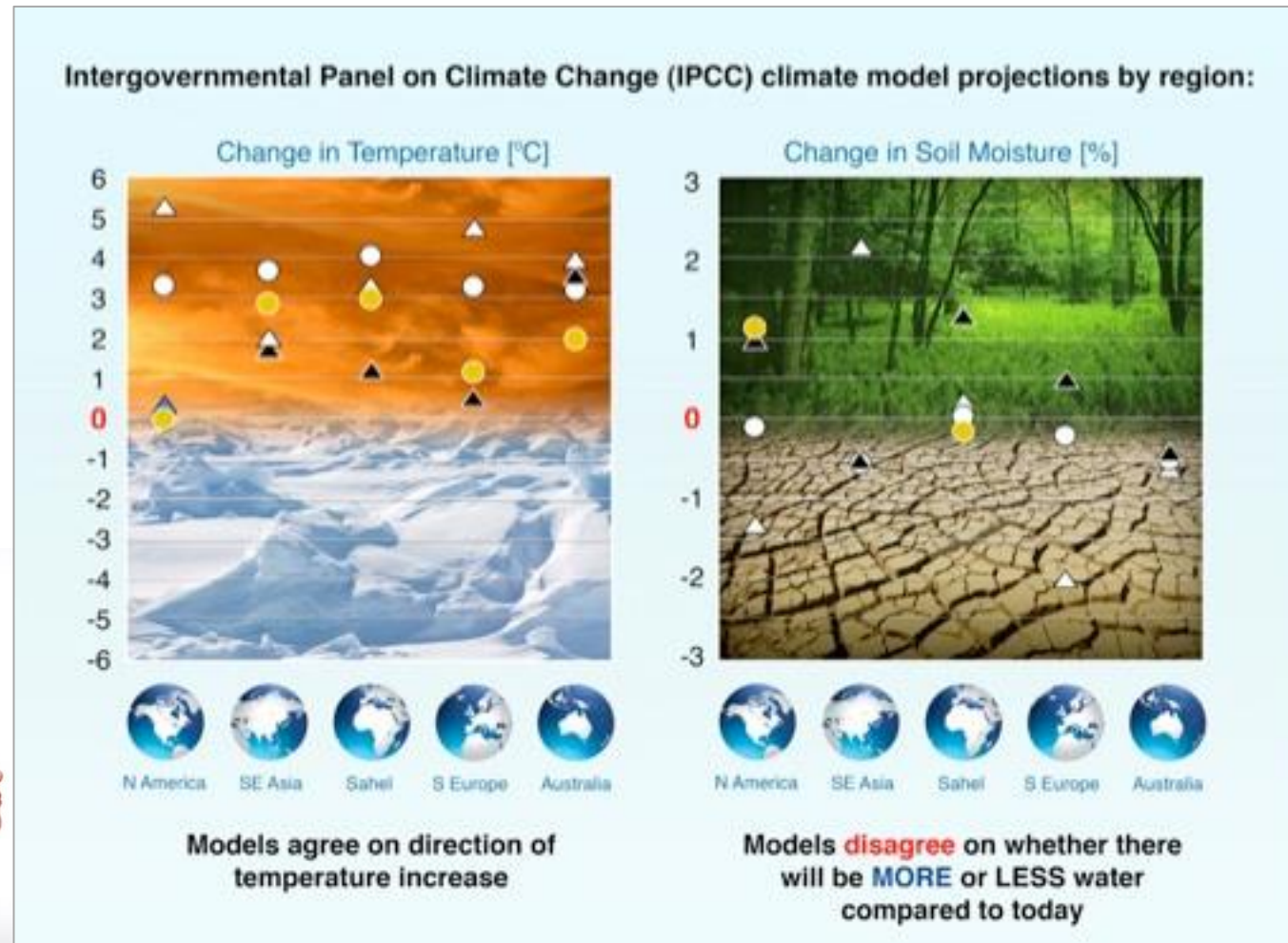
Active (Radar) provides high **resolution** (3 km);

Passive (Radiometer) provides high **accuracy** resolution (40 km)

Continuous 1 000 km swath allows for each site to be reimaged every 3<sup>rd</sup> day  
SMAP will fly at a sun-synchronous (6am/6pm) orbit



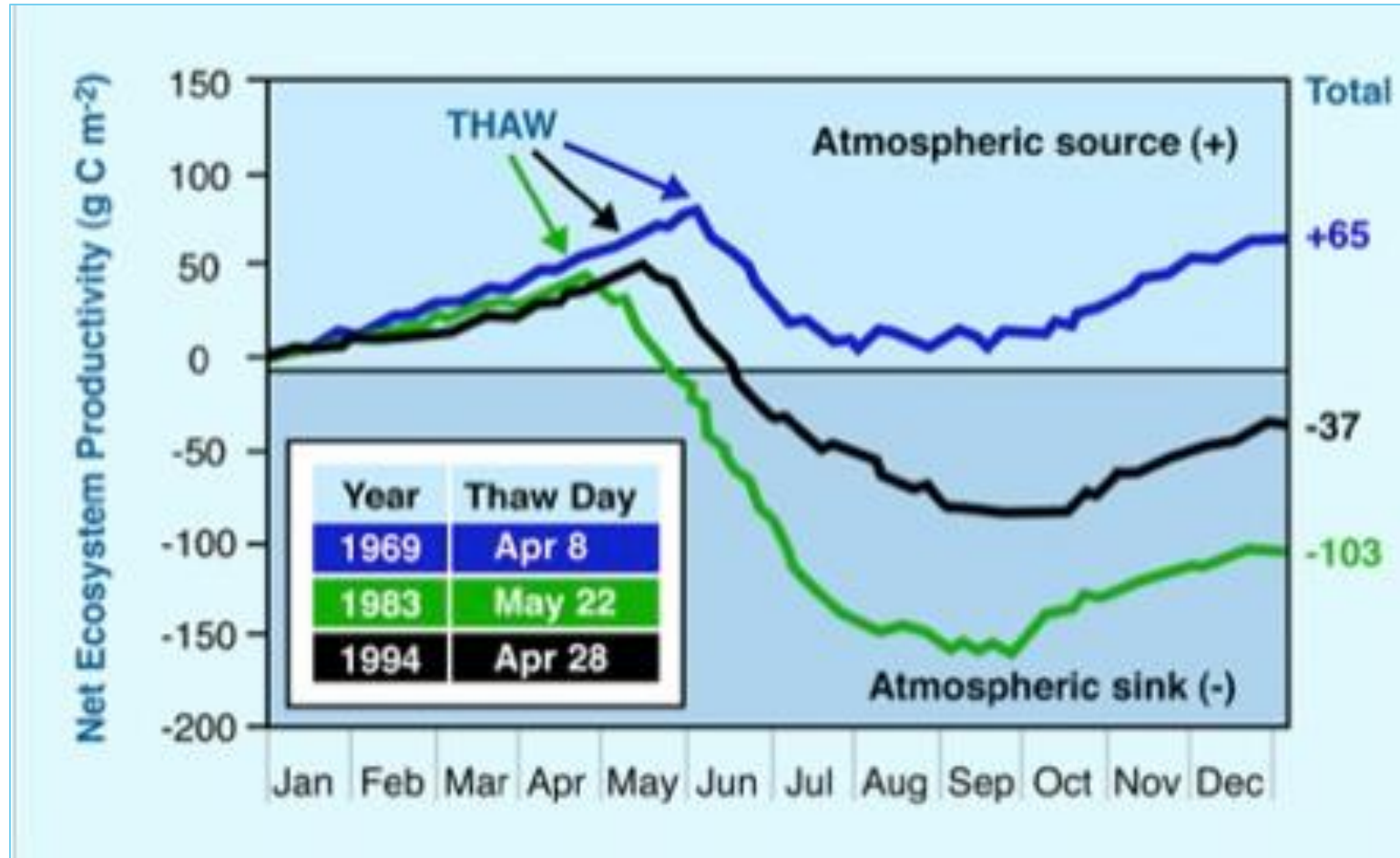
# How will global climate change affect water supply and food production?



*Models disagree; in situ and remotely sensed data could bring agreement among the models.*



# THE GLOBE PROGRAM **SMAP** will also quantify seasonal freeze/thaw state transitions



Why? Soil moisture plays a major role in determining the length of the growing season. Carbon uptake and release is determined by the growing season. Understanding the long-term trends is key in estimating terrestrial carbon sources and sinks.





**THE GLOBE PROGRAM**

**GLOBE schools can help calibrate and validate SMAP data**



## Our World (K-5)



Learn about soil and how different kinds of soil hold moisture. See how NASA plans to use measurements from the Soil Moisture Active Passive Mission, or SMAP, to make Our World a better place to live.

## Real World (6-8)



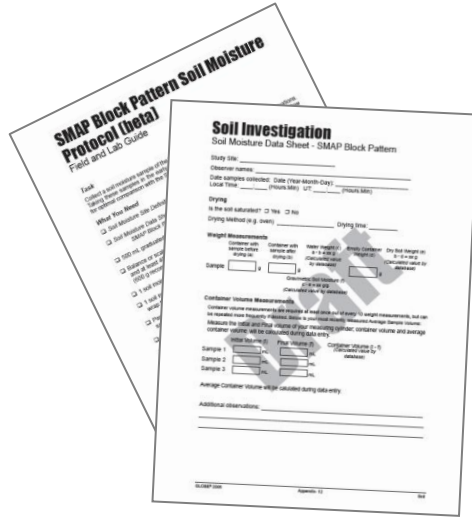
What is the connection between water, soil and carbon cycles? The answer may be in the soil beneath your feet. See how NASA plans to measure soil moisture from space with the Soil Moisture Active Passive Mission, or SMAP. Learn to calculate soil moisture in your own backyard and discover the real world applications for this data.

## Launchpad (9-12)



Learn how NASA's Soil Moisture Active Passive Mission, or SMAP, will use new technologies to help answer questions raised in the National Research Councils' Decadal Survey. See what kind of modeling and forecasting applications the data from this mission will provide as it measures the soil moisture that cools Earth's surface and provides water to the atmosphere and plants.

# Data collection materials for the SMAP Block Pattern Soil Moisture Protocol



Data sheet  
and field  
guide



Oven mitts or hot pads



Wood block



GPS  
Receiver



A scale (0.1 g sensitivity  
& 400 g capacity)



Soil sample can  
with lid



Trowel



Hammer and nail



Meter stick or  
centimeter ruler



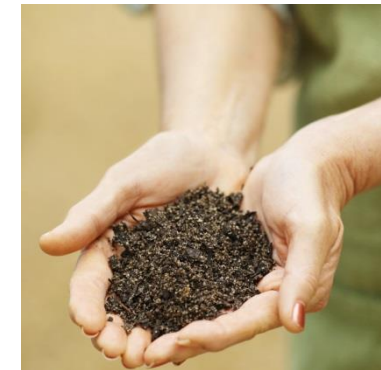
Drying oven



500 mL  
graduated  
cylinder



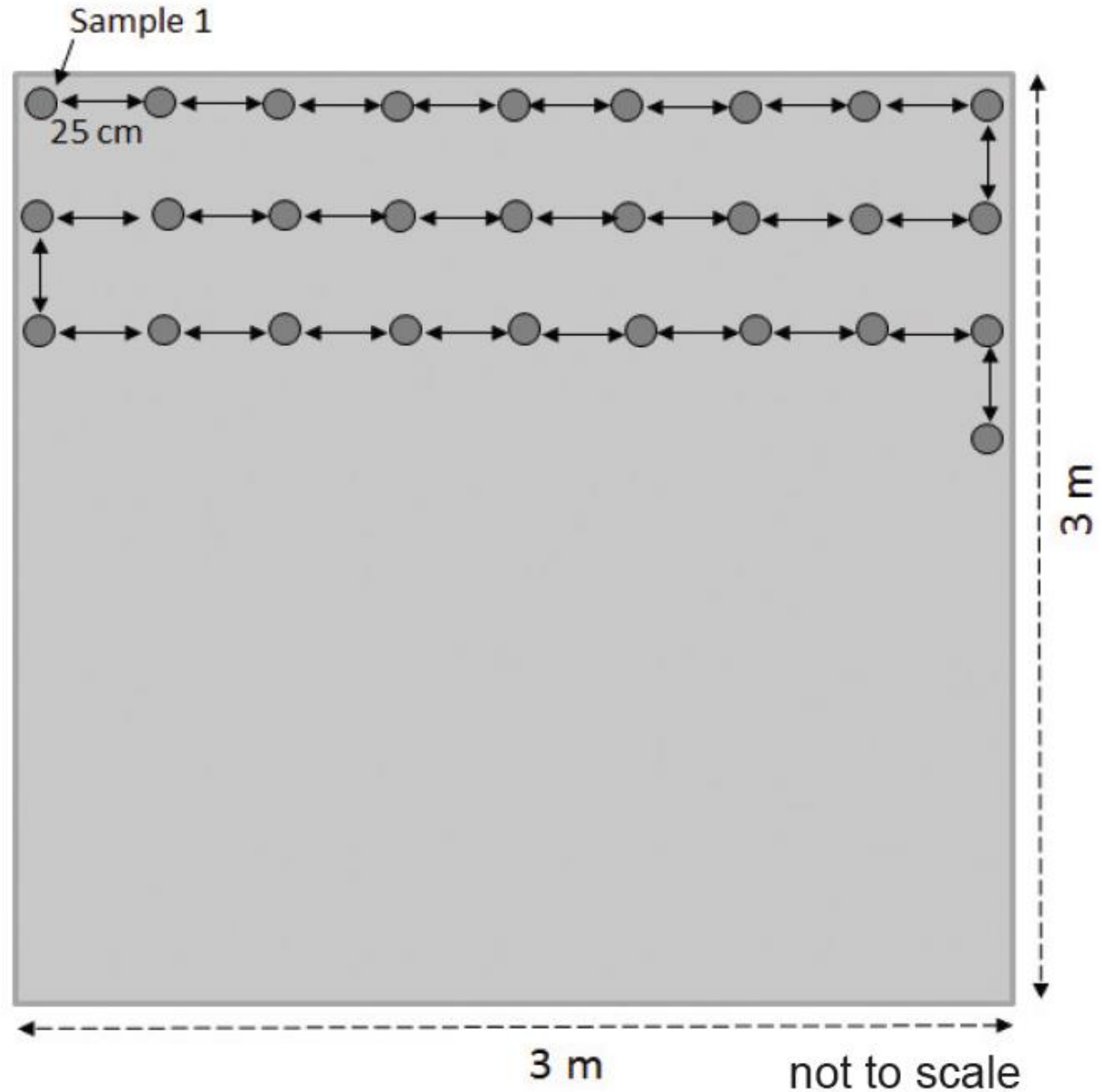
pencil



... and soil!



# **SMAP Block Pattern Sample Site and Sampling Procedure**









# WITH FUNDING FROM NOAA AND EPA...







**WITH FUNDING FROM NOAA AND EPA...**







# WITH FUNDING FROM NOAA AND EPA...

## STUDENT SCIENTISTS

### Tupelo Middle students measure trees, collect water samples

Their data will be logged on website that scientists around the world can access.

BY CHRIS KIEFFER  
Daily Journal

TUPELO — Science proved to be more work than Tupelo Middle School eighth-grader Kimya Jasbi expected.

After spending a class period measuring the trees on the school's athletic field, Kimya said she was surprised to be ducking under branches and getting poked by limbs.

"It was a good experience," she said, "but I didn't like climbing through the trees."

Kimya was among about 300 students participating in a hands-on activity Wednesday with science educators from the University of Southern Mississippi.

The students, from Holly Bailey's seventh-grade science class and Judy Harden's eighth-grade science class, peered at the trees through a tube-shaped instrument called a densiometer; used measuring tape to determine circumferences of trunks; and carried clipboards to record data.

They will log that information throughout the year and record it in an online database that allows scientists to use the results throughout the world.

"Hopefully they will gain an awareness of how science works and what scientists do," said Sherry Herron, professor and director of the Center for Science and Mathematics Education at USM.

Herron joined Shelia Brown at the school Wednesday to give the students a lesson on collecting data. Brown is an educator/biologist at Gulf Coast Research Laboratory Marine Education Center in Ocean Springs, part of USM.



Kate Wheeler and George Patterson measure and record the size of a sycamore outside of the school. Below, Shelia Brown assists Tupelo Middle School students, from left, Wyatt Herring, Marcus Lewis, Lucas Hartigan and Jason Garrett with their recording of scientific data.

The activity is part of a grant that Harden received for the Formal and Informal Environmental Education program. The two classes also aren't the only ones at Tupelo Middle working with USM educators.

Brown was also at the school on Tuesday leading a lesson for seventh-grade math teacher Connie Gusmus and art teacher Leah Patterson.

That lesson about fish, pressure waves and sharks' electromagnetic senses is part of a B-WET grant that Gusmus has received. B-WET is an acronym for Bay Watershed Education and Training.

Gusmus's classes will collect water samples throughout the year and test their pH and levels of oxygen, phosphates and nitrates.

Like Harden's and Bailey's science classes, they will log their information in GLOBE, an online



apply math and science and why scientists do different things," Gusmus said.

Harden's and Bailey's students also will record water samples to GLOBE in addition to their observations about the density of tree canopies and the height and circumferences of the trees. Scientists are able to use that data to observe conditions throughout

ment."

Two groups of students will also go to the Gulf Coast during the spring for even more experience in marine biology.

"It is great that the students get to work with real scientists," Harden said. "It is wonderful for them to meet and talk to people who do this for a living."

Eighth-grader Rachael Malone





# MY UNDERGRADUATE AND GRADUATE STUDENTS

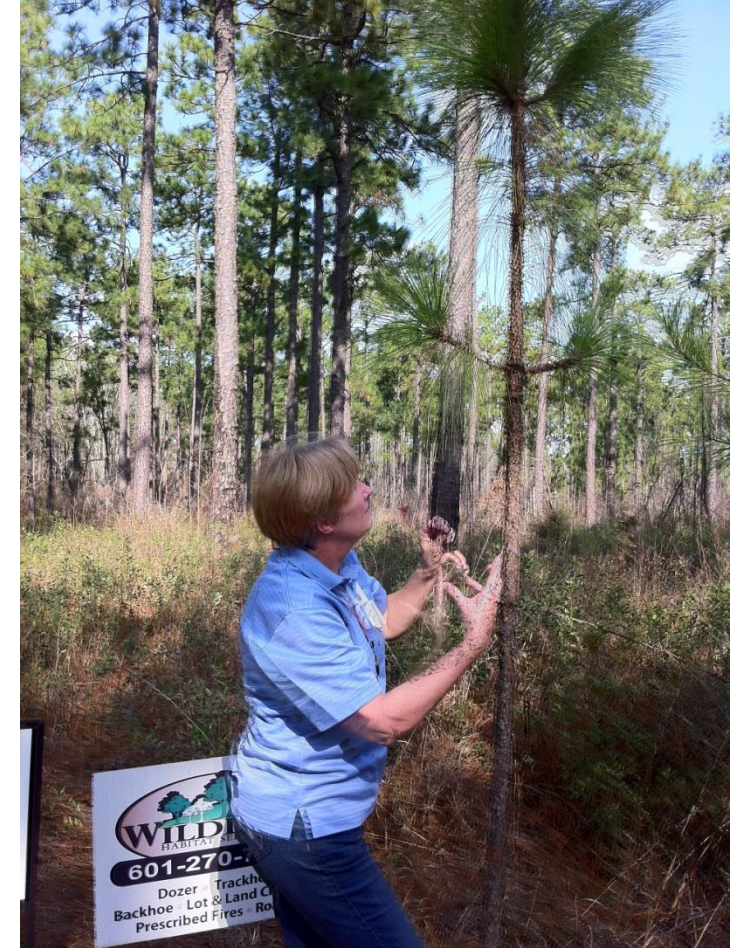
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# LONGLEAF PINE *PINUS PALUSTRIS*



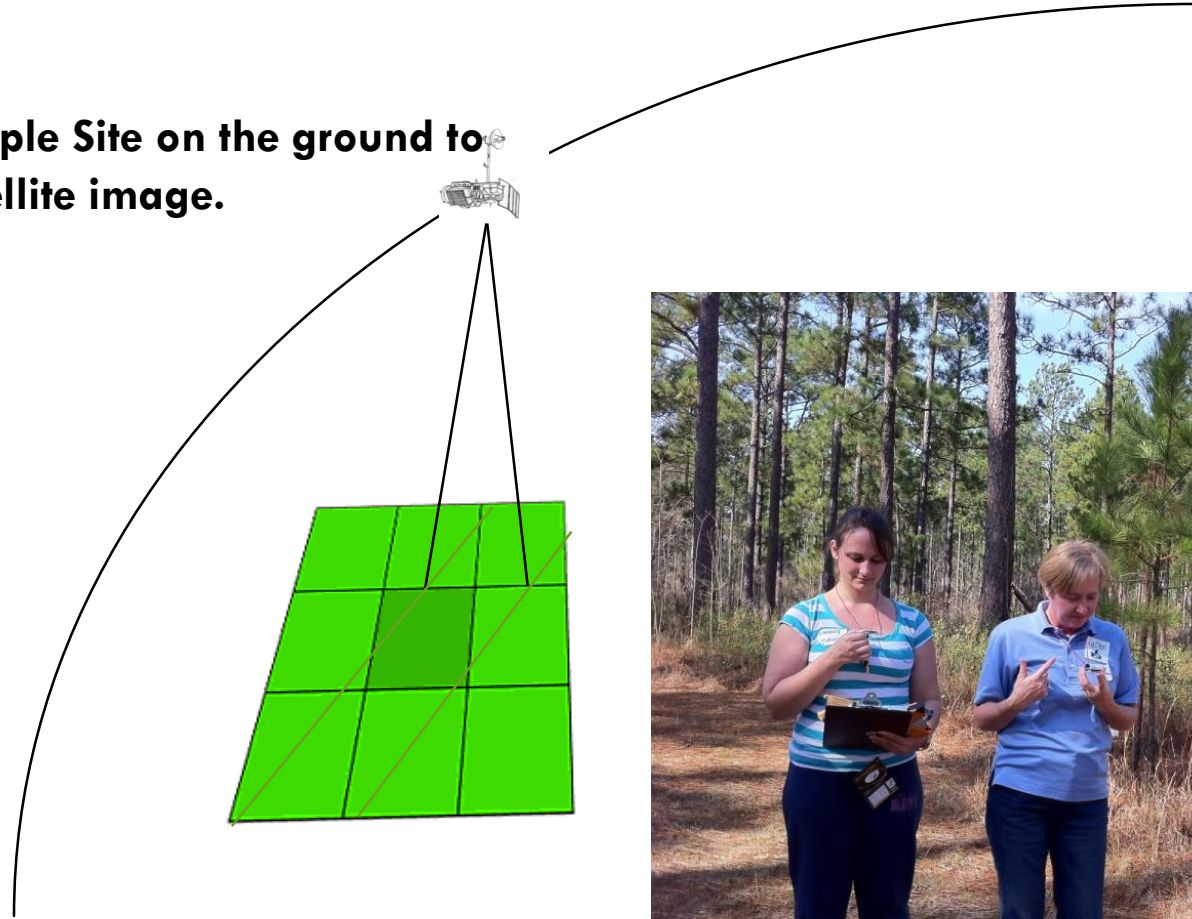
These once dominant trees have largely been replaced by loblolly and slash pines across the southeastern U.S. My students study climate change, the effects of controlled burning in maintaining the longleaf population, compare biomass, and many other studies.





# USING GPS

**We compare each Land Cover Sample Site on the ground to the corresponding area on the satellite image.**







# MEASURING AND MARKING OFF A STUDY SITE IS HARDER THAN YOU THINK!







# Measuring Tree Height with a Home-made Clinometer







# TAPE MEASURE IS USED TO MEASURE DIAMETER AT BREAST HEIGHT (DBH)

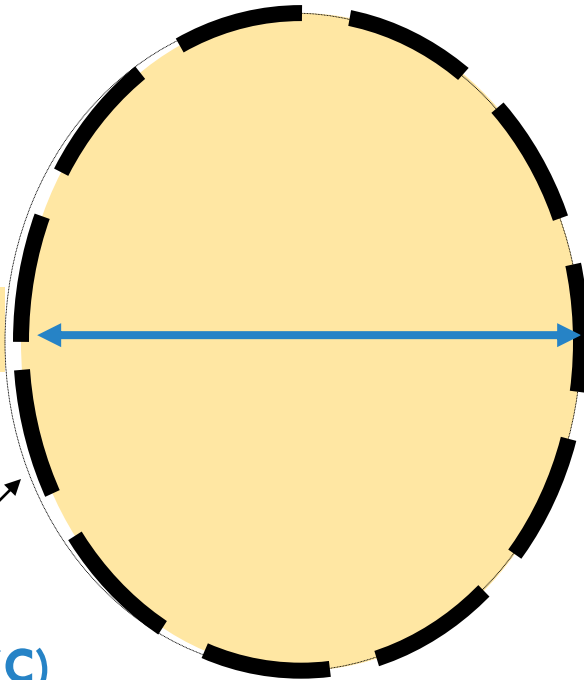
$$\pi = 3.14$$

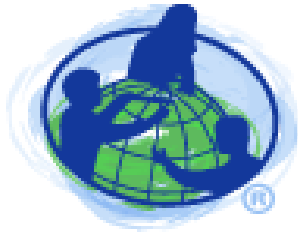
$$D = C/\pi$$

$$\text{Area} = \pi r^2$$

Diameter (D)

Circumference (C)





**THE GLOBE PROGRAM**  
CONNECTING THE NEXT GENERATION OF SCIENTISTS



Investigating the Carbon  
Cycle in Terrestrial Ecosystems

**Carbon Cycle**

<http://globecarboncycle.unh.edu/>





Investigating the Carbon  
Cycle in Terrestrial Ecosystems

## Carbon Cycle

# EXCEL SPREADSHEET WITH PRE-LOADED FORMULAS IS USED TO CALCULATE BIOMASS

### Plot Size

In order to compare your data to data collected by others, our calculation of biomass per plot will be converted to biomass per square meter. This conversion requires some information that you will enter here about your plot size. **Enter data into either 1 or 2 below in meters:**

1. If your plot is rectangular, enter the LENGTH of a SHORT and LONG side
2. If your plot is circular, enter the plot RADIUS
3. If you have an odd sized plot (for instance you've sampled your entire schoolyard, calculate the entire area in  $m^2$ , and add it here)

Calculated plot size in  $m^2$


0
---



Investigating the Carbon  
Cycle in Terrestrial Ecosystems

## Carbon Cycle

Tree #	Species Group	Circumference/ CBH (cm)
1	Pinus palustris	132.91
2	Pinus palustris	138.92
3	Pinus palustris	148.84
4	Pinus palustris	159.83
5	Pinus palustris	76.93
6	Pinus palustris	159.83
7	Pinus palustris	171.76
8	Pinus palustris	127.8
9	Pinus palustris	86.98
10	Pinus palustris	70.97
11	Pinus palustris	113.04

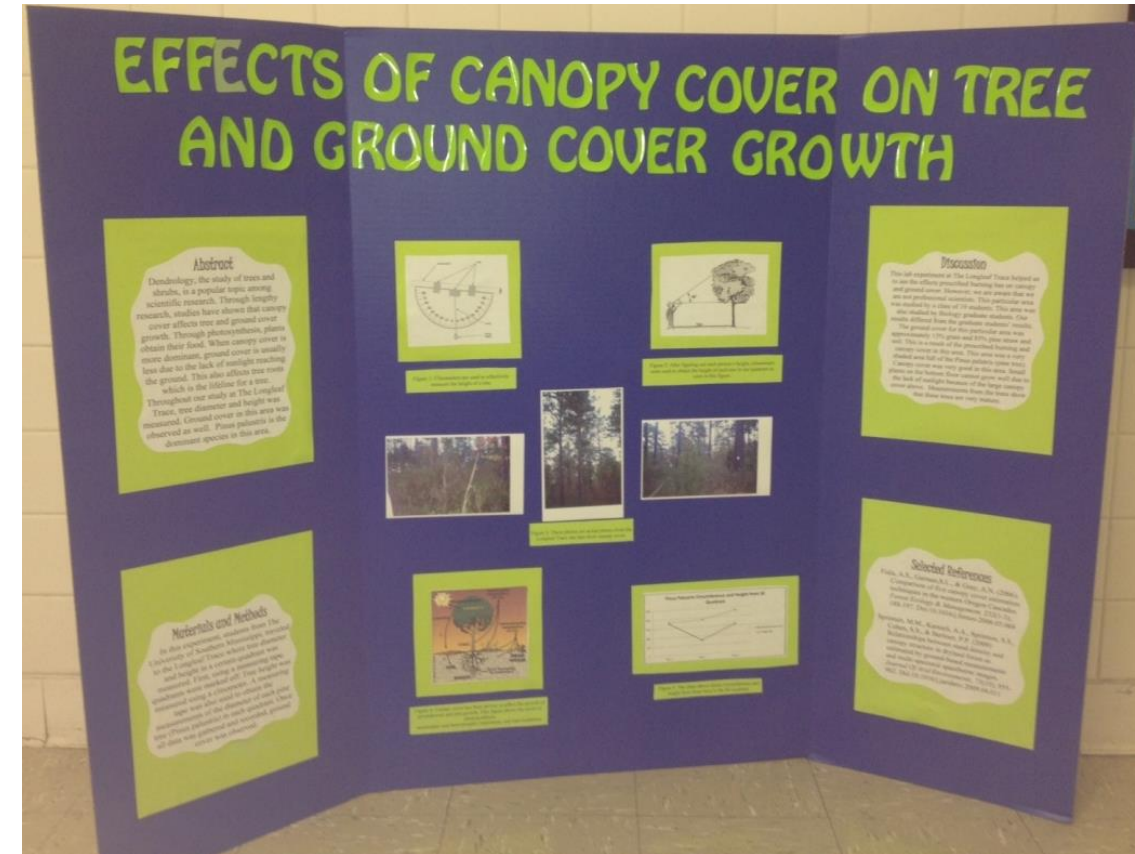
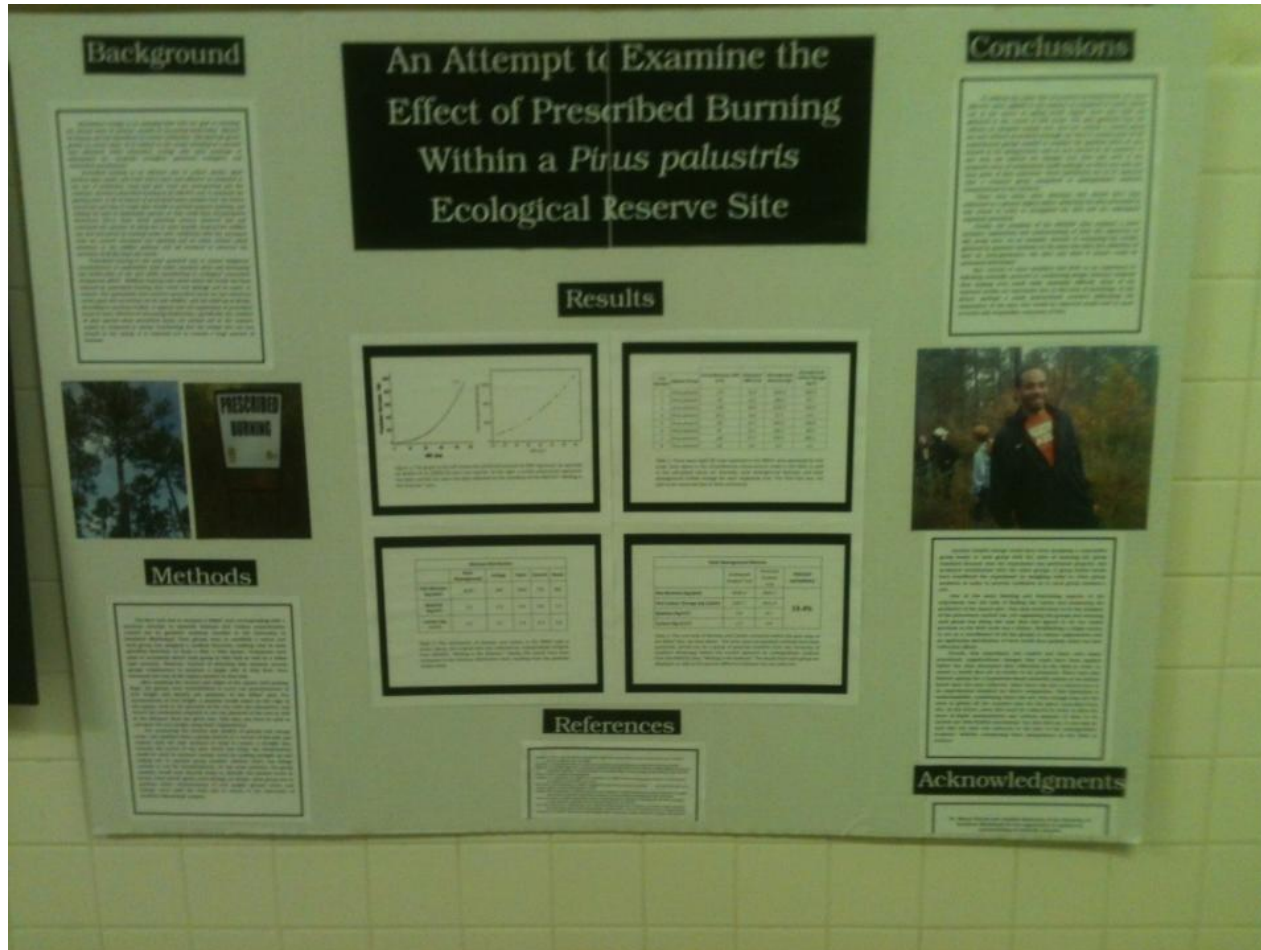
# One of our examples of Biomass Calculation

Table summarizing the tree data					
	Total Aboveground	Foliage	Stem	Branch	Roots
Plot Biomass (kg/plot)	7843	451	6118	1274	1670
Biomass (g/m <sup>2</sup> )	8714	501	6798	1415	1855
Carbon (g C/m <sup>2</sup> )	4357	250	3399	708	928





# Examples of My Students' Presentations







# ACKNOWLEDGEMENTS





# DR. ROSALINA 'LINA' VILLAVICENCIO HAIRSTON

